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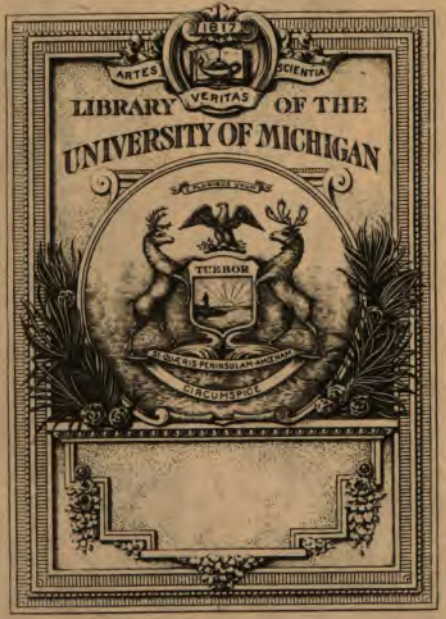
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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, STATE GEOLOGIST

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SOME FACTS AND FIGURES ABOUT NORTH CAROLINA AND HER NATURAL RESOURCES

(SECOND EDITION)

PREPARED BY

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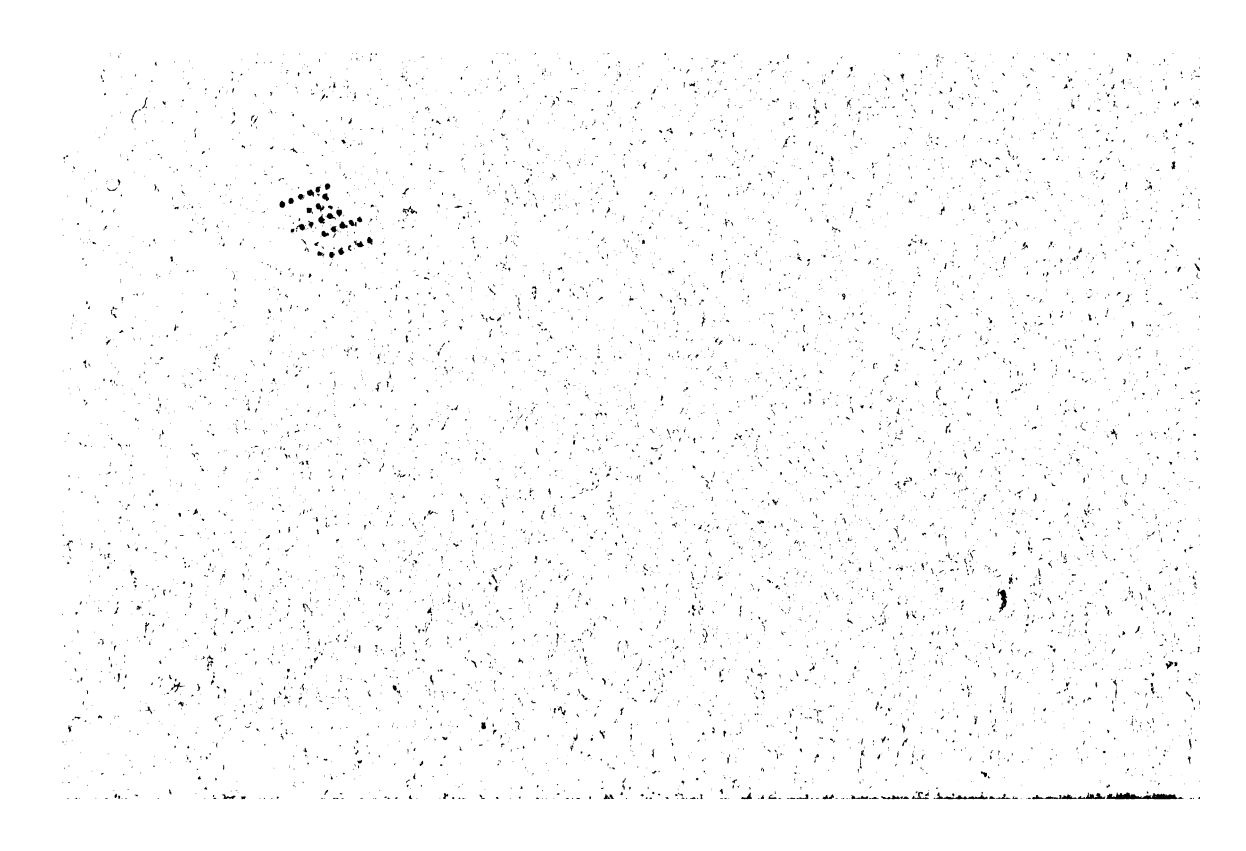

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SOME FACTS AND FIGURES

ABOUT

NORTH CAROLINA AND HER NATURAL RESOURCES

PREPARED BY

N. C. GEOLOGICAL AND ECONOMIC SURVEY

INTRODUCTION

The North Carolina Geological and Economic Survey has been established for two purposes:

(1) To collect and *publish* data concerning the State's natural resources for the benefit of the citizens of the State and for others desiring to become interested in the State as a place of residence or for the investment of capital.

(2) To collect and publish data regarding the adverse conditions which are affecting these natural resources, for the use of the General Assembly of North Carolina, and to suggest such remedies as have proven practicable and feasible in other States and countries where similar conditions obtain.

After a careful and detailed study of the subjects assigned to the Survey in the act establishing it, the conclusion has been reached that the most urgent needs are for proper laws concerning forestry, good roads, drainage, and fisheries.

This booklet has been prepared for the specific use of the members of the General Assembly of 1917, and it is hoped that this brief presentation of these needs,

North Carolina Geological Survey 3-5-179

so vital to the economic development and continued prosperity of our State, will be the means of interesting the members of this General Assembly in these subjects and of bringing them to realize the necessity for some *State policy* in the conservation of our forests, our fisheries, and our soils, and in the economic building of public highways.

More detailed information in regard to any one of the subjects discussed in this book is contained in fuller reports that can be had, upon request, from the State Geologist.

SOME FIGURES ABOUT NORTH CAROLINA AND HER NATURAL RESOURCES

Area (square miles)	52,286
Land area (square miles)	48,666
Water area (square miles)	3,620
Population (1910 census)	2,206,287
Estimated population (1916)	2,400,000
Number of counties	100
Number of townships	980
Real estate (State Auditor's 1915 Report)	$356,924,413
Personal property (Auditor's 1915 Report)	$214,798,933

FORESTS

Number of acres in woodland	19,600,000
Total stand of timber in board feet	43,000,000,000
Value of property destroyed each year by forest fires	$622,000

	Board Feet
Rate of growth per acre at the present time	150
Rate of cutting per acre	350
Amount used up in excess of rate of growth	200

ROADS

Number of miles of public road in State	50,758
Number of miles of improved road (1914 statistics)	10,208
Number of miles of unimproved road (1914 statistics)	40,550
Annual loss to State because of unimproved roads (estimated)*	$11,000,000
Annual expenditure on roads (1914)	$ 5,406,945

FISHERIES

Number of persons engaged in fishing (1908)	9,681
Capital invested in fishing apparatus, boats, etc.	$1,270,000
Value of finfish caught (1908)	$1,776,020
Value of oyster industry (1911)†.....	24,243

DRAINAGE

Number of acres of swamp and overflowed lands in North Carolina (approximate estimate)	3,000,000
Number of acres capable of being reclaimed by drainage	2,000,000
Number of acres now being drained	1,000,000
Number of acres of swamp land drained ..	800,000
Number of acres of overflowed land drained	100,000
Estimated cost per acre of draining and clearing swamp land	$19-$31
Average taxable value of swamp land before drainage	25c.-$1.00

*See Economic Paper, No. 27, pages 72-126.

†Value of oyster industry in Virginia same year, $3,500,000. Our waters are capable of producing just as good oysters, and as many of them, as Virginia.

Estimated increase of value per acre after draining ..... $25-$150
Estimated increase in value of all lands drained to date $50,000,000

MINERALS

Value of mineral production during 1915..$3,583,925

WATER-POWERS

Available water-power, approximately ..445,0000 h. p.
Amount now being utilized, approximately .....223,000 h. p.

FORESTS

The total area of North Carolina is 31 million acres, of which a little over 19 million acres, or 63 per cent, is forest land. Nearly two-thirds of all the land in the State is producing a timber crop, and yet the State has only just begun to do anything to increase the average yield of that crop, or even to protect it from extinction.

DEMAND FOR TIMBER

The wood-using industries of the State are second in value only to the cotton manufactures, and they are really of more importance than these, because they are scattered all over the State, and furnish employment to more men than any industry outside of agriculture.

North Carolina continues fourth among the States in the amount of lumber cut, while she is first in the number of sawmills. The United States Census Bureau reported a cut of 2,227,800 board feet of lumber in 1914, produced by 2,824 sawmills. Of this amount, our own manufactures took and worked up at least one-third. These factories, which turn out builders' supplies, furniture, vehicles, packing material, and many other things, obtain 96 per cent of their raw material from our own State. They complain, however, that the prices of this raw material are rising, the supply diminishing, and, what is worse still, the quality of the available timber rapidly declining.

TIMBER SUPPLY

A fairly close estimate was made some time ago of the standing timber in the western part of the State, the result of which gave an average stand in the mountains of about 3,500 board feet per acre, and

in the western Piedmont region of 1,200 board feet per acre. From this it was roughly estimated that the average stand all over the State was betwen 2,000 and 2,500 board feet per acre. This meant a total stand of merchantable timber in North Carolina of between 40 and 50 billion board feet. Cutting has continued and increased to such an extent since this estimate was made that the available supply of timber has undoubtedly fallen to 40 billion feet or less.

ANNUAL CUT

There is an annual cut of merchantable timber in North Carolina of about 4 billion board feet, including lumber, shingles, ties, staves, pulpwood, poles, etc., or an average annual cut from the woodland of 200 board feet per acre. In addition to this, it is estimated that there are 5,720,000 cords, equivalent to nearly 3 billion board feet of cordwood, cut every year for firewood and other purposes. This means a total annual cut of what is equivalent to 350 board feet of timber per acre for all the woodland in the State.

ANNUAL GROWTH AND RESULT OF OVERCUTTING

Our forests, in their present unprotected and mismanaged condition, are not, on an average, growing more than 150 board feet of wood per acre per year. With a cut of 350 board feet it is plain that we are annually using up 200 board feet more of timber than the forests are producing. At this rate it will not be very long before we have used up all the merchantable timber in the State.

OTHER RESULTS OF OVERCUTTING

But this is not all. Rivers which only a short time ago were even-flowing streams are now so variable

that they cannot be depended upon for waterpower. Rich bottomlands, once the main dependence of the river farmer, are now worthless through the filling up of the smaller streams, or because they have become covered with sand or washed away by the larger rivers. Millions of tons of our finest farming soil is washed from our hillsides annually; and to repair it we spend millions in fertilizers.

These results are brought about partly by excessive clearing and uncontrolled lumbering operations, but are due chiefly to the practice of burning the woods.

ANNUAL DAMAGE BY FIRES

During the past seven years there has been a reported damage from forest fires in less than half the townships of the State of $622,000 annually. If indirect injury were taken into account, and the whole of the State reported for, it is certain that the damages to the forests would amount to $1,000,000 a year from this cause alone.

The spring fires of 1916 were the worst so far recorded, practically $4,000,000 worth of property being destroyed in the two months of March and April. The counties suffering most were the following: Carteret, Bladen, Craven, Pender, Beaufort, Duplin, Pamlico, Brunswick, McDowell, Burke, Haywood, Wilkes, Caldwell, Avery, Stokes.

PRINCIPAL CAUSES OF FIRES

Forest fires in North Carolina are caused largely by carelessness, less than 10 per cent being attributed to malicious or incendiary origin. Railroads and other users of spark-producing engines set about 30 per cent of the fires, while the carelessness of individuals, such as farmers burning brush, hunters, boys with cigarettes, etc., cause about 42 per cent more.

Less than 10 per cent are described as of unknown origin.

A FOREST POLICY FOR NORTH CAROLINA

North Carolina, with so much at stake, should have a definite and up-to-date forest policy. This should include policies of education, of demonstration, and of forest protection. In the future a policy of acquiring and holding forest lands for the permanent benefit of the State and its industries might be adopted.

FORESTRY EDUCATION

In order to secure the general adoption of better methods, the people must learn about them, so that they will appreciate their value. The State Forester should make addresses at different places over the State, give talks at Farmers' Institutes, write articles for the papers, and prepare bulletins for the people on the subject of forestry. This policy is already being carried out as far as possible by the Forestry Division of the North Carolina Geological and Economic Survey; but there is room for its extension.

FORESTRY COURSES

Forestry courses should be given in the State University, the Agricultural and Mechanical College, the Negro Agricultural and Mechanical College, the Agricultural High Schools, and other State-aided institutions. The object of these courses should be, not to train professional foresters, but to provide such instruction in forestry and allied subjects as would fit the citizen to conservatively manage his forest property or be able to intelligently help carry out the forest policy of the State.

ARBOR DAY

The children of the public schools should be given elementary instruction in forestry, to make them appreciate the value of forests to the State and the advantage of proper care in their management. The establishment by the last Legislature of a State Arbor Day, to be observed by all the schools with appropriate exercises, and the preparation and distribution of Arbor and Bird Day Manuals to the schools, has had a very wide influence; but there is room for a much wider observance of this day.

ASSISTANCE TO OWNERS OF WOODLAND

The State should provide expert advice and assistance to farmers, and other woodland owners, not only in the general management of their property, but in the disposal of their timber crops. The local as well as general markets for timber of the various sizes and species should be studied, so that the farmer might receive full value for the material which he has for sale. The Survey has been unable to emphasize this work as it deserves, though it has assisted those landowners who have sought advice, as far as has been possible.

DEMONSTRATION AREAS

The State should acquire, by gift or purchase, suitable areas in the different regions of the State, and on these lands experiment with and practice the kind of forestry best suited to the farmers' wood-lots and other forest lands of such regions. These experiment and demonstration forests could be permanently held by the State and would serve to demonstrate by actual practice how forestry can be made to pay. Meetings held from time to time at such demonstra-

tion forests would acquaint the people of the whole region with approved forestry methods.

Through the coöperation of the State Sanatorium for the Treatment of Tuberculosis, one such State Forest has been started on the State land in Hoke County controlled by them. If sufficient land can be secured, it is planned not only to conduct experiments in forestry, but to show what can be done in reforesting longleaf pine, thereby greatly increasing the beauty and the value of these State lands. Similar areas should be secured in the other timber regions.

PROTECTION OF FORESTS FROM FIRE

The State should provide protection from fire for the property of its citizens. This was recognized by the last Legislature in the passage of the Forestry Law. If the appropriation for its enforcement had also carried, this law would now be bearing good fruit in the saving of much unnecessary loss. The chief provisions of this law are as follows:

1. The State Geological Board is authorized to prevent and control forest fires in any and all parts of the State and to coöperate with the Federal Government in the protection of our forests.

2. The State Forester may appoint township and district forest wardens where it may be deemed necessary. He shall instruct and have supervision of such wardens and shall cause violations of the forest fire law to be prosecuted.

3. Forest wardens shall prevent and extinguish forest fires. In doing this they may patrol, post warning notices, arrest offenders, summon assistance, require the use of horses or other property, and make necessary reports to the State Forester. They shall receive compensation for the time actually employed

at a rate not to exceed 20 cents per hour and reasonable compensation for other necessary and allowable expenses.

4. The old law concerning burning the woods was incorporated into the new law in a somewhat strengthened form, so that it is still unlawful to set fire to one's own fields or woods without first notifying neighboring landowners, or to let such fires escape to any neighbor's property.

5. In order to further prevent and control forest fires it is made unlawful to destroy or deface fire-warning notices, to kindle camp-fires in dangerous places, to leave camp-fires burning, to in any way start a fire without fully extinguishing it, or to burn any material without keeping a competent watchman in charge of it.

APPROPRIATION

As soon as an appropriation is available all provisions of this law will be put into force, as the machinery for its enforcement is already in existence and much of the necessary preliminary information is now in the hands of the Survey. Ten thousand dollars is needed at once to make this law effective by providing an efficient fire preventive and fire fighting force for those parts of the State that stand so sorely in need of protection.

ADVANTAGE OF THE FOREST WARDEN SYSTEM

The fire warden system puts in the hands of local State officers, supervised by a central State officer, duties which, though recognized as duties, have heretofore been left to the private citizen. Only such State officers can, for instance, successfully institute and press prosecutions, because private parties are afraid or do not like to antagonize their neighbors.

With one or more men in a township whose special duty it is to take precautions to prevent and control fires, the citizens will gradually learn to exercise greater care in the use of fire, and a spirit of coöperation will grow up which will eventually entirely prevent fires.

FEDERAL ASSISTANCE

Under the Weeks Law a fund has been provided to assist the State in fire protection on the headwaters of navigable streams in those States that have some paid system of State fire protection. The amount given by the Government cannot exceed the amount spent by the State for the same purpose. It may, however, go up to $10,000 if the State spends that much. Since the enactment of the Forestry Law the Survey has been enabled to secure a small apportionment from this fund, and from two to four Federal patrolmen have been employed during the past three fire seasons. During that time somewhat more than $1,000 has been spent, and the results accomplished have far outweighed the cost. Coöperation in fire protection has been accomplished with the Tryon Forestry Club in Polk County, the Mount Mitchell Forest Protective Association in Buncombe, Yancey, and McDowell counties, and the Linville Forest Protective Association in Avery, Watauga, and Caldwell counties. As soon as the State is in a position to actually spend money in protection, landowners in nearly every county will demand State or Federal assistance.

A State appropriation of $10,000, such as is needed, will enable us to secure from the Federal Government possibly an equal amount to be spent in fire protection.

GOOD ROADS*

The vital necessity of a State system of good roads as well as systems of county, township, and neighborhood roads, which will make it possible not only for each citizen to market his produce at the least cost, but lessen the present enormous tax which each one who travels the highways of North Carolina now pays to bad roads, is being realized as never before by a majority of our people.

This realization has manifested itself during the past four years in the voting of many bond issues and special taxes by counties and townships for road improvement; by contributions of money and labor from private individuals; and by a general movement throughout the State for bettering our road conditions.

Through various methods employed by counties and townships during the past four years, there has been made available for road work approximately $21,620,000 (these figures are estimates, as the latest tabulated statistics we have at present are for 1914), of which $8,294,000 was raised by bond issues; $7,530,000 by special taxes; $3,691,000 is the estimated market value of the labor tax; and $2,110,000 is the estimated value of the convict labor employed on the public roads during this period.

As a result of this expenditure, it is estimated that about 8,000 miles of roads have been surfaced, and about 6,000 miles graded, making a total of 14,000 miles improved. This leaves, out of a total mileage of 50,758 miles, 36,758 miles of unimproved dirt road. It is estimated that we have spent approximately $12,935,000 in road construction during this period, and

*A good road is one that is good 365 days in the year.

$8,691,000 in the maintenance of our dirt roads. That the results, as we know them, have not yielded what should have been obtained from this large expenditure is due largely, we believe, to:

A lack of system and method in the administration of road funds;

Lack of expert engineers to take charge of the location and construction of the roads;

Lack of uniformity in county road laws;

Present inadequate methods of maintenance, showing futility of the use of a labor tax;

Need for closer coöperation between county and State officials;

Lack of general State and county plans for systems of highways;

Lack of legislation in regard to width of tire to be used on public highways, an important factor in maintenance;

A tendency to make the unit of government too small in the issuance of bonds. It is believed that the best results can be achieved from a county bond issue.

WHAT THE GEOLOGICAL SURVEY HAS BEEN DOING

The Highway Department of the Geological Survey has been working to bring our people to a realization of the futility of the existing methods, or lack of method, in road work, with the result that many counties are now employing engineers or seeking expert advice and assistance from the State in the expenditure of their road funds. The work of this Department, has of necessity, been largely of an educational character, through pamphlets published and distributed by the Survey; through press articles prepared by members of the Survey staff; through circu-

lars distributed broadcast over the State; through lectures and addresses by the State Geologist and his assistants in practically every county and most of the townships of the State; through State conventions held annually, and sometimes oftener; through exhibits of road pictures, road materials, road models, etc., at the State Fair and at local county fairs through the holding of Good Roads Institutes at the University; and, in short, every avenue for the dissemination of information in regard to the value of good roads and the best methods of road building has been employed.

Under the supervision of this Department, the work on the Hickory Nut Gap Road (part of the Charlotte-Asheville Highway), as authorized by the Legislature of 1913, has been completed; and the Survey also had had general supervision in Madison County in connection with building a portion of the Central Highway through that county, as authorized by a special act of the Legislature.

Road Institute.

Another form of educational work undertaken by the Survey in coöperation with the State University, and later with the aid of the State Highway Commission, has been the holding of a Road Institute at the University for one week during the winter of each year for three consecutive years. That this Institute is supplying a vital need in North Carolina is evidenced by the fact that there has been a steady increase in its atttendance, those attending representing every kind of official connected with road work in the counties and townships of the State. At the first institute held in 1914 there were 24 counties represented, with 54 men attending; at the second institute, held in 1915, there were 29 counties represented,

with 80 men attending; at the third institute, held in 1916, there were 127 men present, representing 43 counties. The object of this Institute is to bring together each year the men who are actually engaged in our road work, and give them information, through lectures and practical demonstrations, as to the latest and the most efficient methods of road administration, location, construction, maintenance, use of machinery, bridge construction, etc.

Road Conventions

Coöperating with the North Carolina Good Roads Association, the Survey held in June, 1916, at Wilmington, Wrightsville Beach, the largest road convention ever held in this State, or in the South. About 1,200 delegates were registered, representing practically every county in the State. The slogan of the convention was "State Roads," and it is believed that an impetus was given to the building of long continuous stretches of good roads connecting county-seat with county-seat, and the eastern with the Piedmont and Western sections of the State, an idea which will eventually result in a *system* of *State roads*. That the counties and the State are getting away from the old idea of simply building short stretches of neighborhood road, resulting in a few miles of good road, followed by many miles of very bad road, is felt to be a distinct advance. As a direct result of this convention, there is a movement on now for building certain intrastate highways to extend across many counties, such as the Wilmington-Fayetteville Highway, Wilmington-Goldsboro Highway, Charlotte-Pinehurst-Raleigh Highway, Wilmington-New Bern Highway, and many others.

Collection of Statistics

The Survey has continued to coöperate with the United States Office of Public Roads and Rural Engineering in the collection of data relating to the financing and building of roads in North Carolina. These data enable us to take stock of where we stand along this line, and help us to realize the efficiency or nonefficiency of our present methods, by comparing what we are spending with what we are getting for this expenditure. It might be stated here, however, that the report for 1914 (the most complete yet obtained) is still in the hands of the Commissioner of Labor and Printing, not published because of lack of printing funds. The value of this report to the people of the State is being greatly diminished because of its not being published at the proper time. The collection and tabulation of these data cost the State a great deal in money and time, and the nonpublication of this report is a distinct loss.

It is believed that these data for 1914 will be of interest and profit to those who are interested in studying and finding a solution for our road problems, and below are given some figures:

Road Mileage

Number of miles of public roads in the State	50,758
Number of miles of surfaced road (macadam, sand-clay, gravel, or specially surfaced) in the State	6,027
Number of miles of graded road, but not surfaced	4,181
Total number of miles of improved road (graded and surfaced)	10,208
Number of miles of road improved (surfaced and graded) during 1914	2,535
Number of miles of unimproved dirt road in the State	40,549

Road Revenue

Amount of State taxes collected for roads during 1914 (including dog tax, railroad tax, Central Highway tax, chain-gang tax, automobile tax, private subscriptions, Federal funds, etc.)	$2,105,238.00
Number of men reported subject to labor tax	121,225
Average number of days worked by these men	5.17
Number of days work from labor tax	676,733
Value of labor tax at $1 per day	$676,733.00
Value of bonds issued during 1914 for building roads	$2,422,400.00
Estimated value of convict labor used on roads during 1914	$460,250.00
Total amount spent on roads during 1914, money, and labor	$5,406,945.00

BY WHOM SPENT

The money is spent, as a rule, by the county commissioners, but in special cases by township commissioners, county road commissioners, or township road commissioners.

INADEQUATE MAINTENANCE

It is a matter of common knowledge that the present system of road maintenance, carried on in many counties by free labor, results in nothing of permanent value and seldom affords even temporary relief from bad conditions; so that the enormous amount expended for this purpose (at least $1,000,000 per year) is practically thrown away.

COST OF BAD ROADS

It has been estimated that the present system of bad roads is annually costing the people (principally

the farmer) over $12,000,000 in increased cost of hauling over the normal cost of hauling a similar load over an improved road. (See Economic Paper, No. 27, of the North Carolina Geological and Economic Survey, pages 72-128.)

While such a condition cannot be immediately eliminated, yet it is felt that steps should be taken to do away with this burdensome indirect tax, even if it is necessary to impose a direct tax, infinitely small in comparison.

FEDERAL AID

In July, 1916, Congress passed an act appropriating a certain sum for State aid in the construction of highways. North Carolina receives the first year approximately $115,000 from this source, and an increasing amount each succeeding year. These funds are to be expended under the direction of the State Highway Commission coöperating with the Secretary of Agriculture. The money is to be spent on the main highways of the State, and each dollar of Federal money must be duplicated by the State or county. Also provision must be made for guaranteeing the maintenance of the roads on which the money is expended.

MAINTENANCE FUND

It is believed by those who have studied the question that the most logical and feasible source of revenue for this maintenance fund is the automobile tax, and that this fund should be in the hands of the State Highway Commission for the maintenance of the main highways of the State. When you consider that the motor travel is not a local matter, and that the automobilists are constantly using the roads of other counties in all sections of the State; that the tax is imposed because of the damage the motor ve-

hicle is supposed to do the roads, it can readily be seen that it is eminently fair and proper that this tax should be used to repair the damage done to the roads most traveled by the automobilists, i. e., those which we term the main highways of the State. In section 8 of the act establishing the State Highway Commission a system of State Highways is defined as being those "connecting by the most direct and practical route all the county-seats and the principal cities of the State." With this fund the State Highway Commission would be able to maintain the main highways, including those which are built through the coöperation of Federal, State, and County Governments.

SUGGESTED LEGISLATION FOR MORE EFFICIENT RESULTS IN OUR ROAD WORK

STATE

1. Increase in the fund for the support of the State Highway Commission to at least $75,000 per year.

2. The establishment of a fund for the maintenance of State highways. It is believed that the automobile tax should be used for this purpose. (See page 21.)

COUNTY

3. Passage of a general law relating to the issuance of bonds by counties or townships, embodying the following points:

(a) Define amount of bonds which may be issued in relation to assessed value of property in the county.

(b) Define rate of tax sufficient to cover interest and sinking fund on bond issue and provide funds sufficient to insure the *systematic maintenance* of the roads to be built by the bond issue. This latter provision is considered most essential.

(c) Provision that the roads on which the bond issue is to be expended must be properly located by a competent engineer approved by the State Highway Commission.

4. Use of all able-bodied State convicts in the construction of State highways.

5. Have a uniform county road law embracing the following points:

(*a*) Have in each county a Road Commission, nonpolitical, the members to be chosen because of their integrity and business ability.

(*b*) Provide that the roads to be built by the county out of a bond issue, or other funds, shall be located by the State Highway Engineer, or an engineer approved by the State Highway Commission.

(*c*) Provide for the organization of the road forces of the county on a systematic basis, having for a road superintendent a man whose ability for such an office would meet with the approval of the State Highway Engineer, to whom he would be responsible for the quality of work done.

(*d*) Provide that bridge construction shall have the plans and specifications approved by the State Highway Engineer, and the final award of contract for bridges to be approved by the State Highway Engineer.

(*e*) Provide an annual tax sufficient to inaugurate a system of maintenance not only for the surfaced roads, but for the dirt roads of the county and for the organization of maintenance forces according to plans approved by the State Highway Commission.

DRAINAGE

The promotion of the reclamation of the swamp lands of the Coastal Plain region and of the overflowed areas of Piedmont and Western North Carolina, through drainage, has been one of the undertakings of the Geological Survey which has yielded to the State splendid results. This drainage was begun with the passage of the general Drainage Law by the Legislature of 1909, and its subsequent amendment by the Legislatures of 1911 and 1915. In North Carolina the swamp acreage is approximately 2,950,000 acres, with probably an additional 500,000 acres of overflowed lands, all of which could be made more healthful and rendered productive by drainage.

Up to the present time there have been organized 123 drainage districts, 38 of which have been fully organized and the drainage completed; 20 have been completely organized and the drainage work is now being done; 42 are still in process of organization; 11 have been organized, but for one reason or another the work has not started on the ditching and canals; and 12 have been abandoned. Through this work, approximately 850,000 acres of swamp land have been reclaimed, and 100,000 acres of overflowed lands in Piedmont and Western North Carolina. It is estimated that the cost of draining the swamp land varies from $4 to $6 per acre and for the drainage of the overflowed land in Piedmont and Western North Carolina the cost varies from $15 to $25 or more per acre. The reclamation of these lands means that land which was formerly bringing in no revenue to its owner and was a menace from the standpoint of health, is now producing from 40 to 100 bushels of corn per acre, from 1 to 2 bales of cotton, and other crops in like proportion. This reclaimed land, in fact, is the most productive and richest in the State, and

will produce in abundance any crop which can be grown in this climate. When it is realized that the taxable value of this land before being drained was from 25 cents to $1 per acre, that it costs from $19 to $31 per acre to drain and clear it, and that after this is done it can be sold at from $50 to $150 per acre, some idea can be gained of the tremendous import to the State of draining approximately 800,000 acres of swamp and overflowed lands. A conservative estimate of the agricultural value to the people of North Carolina through this drainage work is $50,000,000, without even taking into consideration the gain from the standpoint of health.

There are certain amendments to the Drainage Law which should be passed to make the law more elastic and the drainage bonds more salable. These amendments have been worked out by the Legislative Committee of the North Carolina Drainage Association, consisting of men who have had practical experience in drainage work and in carrying out the Drainage Law, and it is hoped that the Legislature will *pass these amendments as presented,* because it means a great deal of very painstaking work to draft the amendments in accordance with the law and decisions of the Supreme Court relating to drainage and at the same time to bring out the practical points needed to facilitate the drainage work.

It is believed that this tremendous work of reclamation and conservation can be facilitated if the State will provide for the employment of a drainage engineer through the Geological Survey, who would have charge of preliminary examinations of drainage districts, the object of these examinations being to decide whether the drainage scheme is practicable and should be undertaken by the owners of the land in the district.

GEOLOGY AND MINERAL RESOURCES

Since its organization the Survey has undertaken investigations of the geological formations of the State, the occurrence of various minerals, their commercial value, and methods of mining. The extent of these investigations has been limited because of the small amount of money available to expend on such investigations, but in a number of instances the Survey has had the advantage of coöperation from the United States Geological Survey, the United States Bureau of Mines, and other Federal departments in connection with certain investigations and the preparation of reports on same. This was notably true in the preparation of Volume III on the Coastal Plain Region. It is through the study of the geology of this region that the Survey was able to prepare data of value to this section in connection with its artesian water supply.

In coöperation with the Bureau of Mines, an investigation was made of the feldspar deposits of the western part of the State. Results were obtained which have led to the mining of feldspar at several places, and the growth in two years of an industry worth now practically $100,000 per year.

A number of the minerals which North Carolina can produce in commercial quantity have come into great demand since the beginning of the war in Europe, and the Survey is constantly having inquiries for deposits of copper, mica, talc, limestone, feldspar, iron, barytes, corundum, and certain of the rare minerals. Because of the very great rise in the price of copper, the North Carolina deposits are now good commercial propositions; and, in coöperation with the Virginia Geological Survey, a report on the Virgilina District has been prepared and is now in the hands of the printer.

It is believed that a detailed study of the limestone and marl deposits of the State is especially opportune at this time, in view of the scarcity of potash and the high prices which farmers are having to pay for their fertilizers. Funds should be made available for the preparation, publication, and very free distribution of such a report.

The mineral production of North Carolina during 1915 amounted to $3,583,725, divided as follows:

Stone	Granite	$1,246,810
	Sandstone, Marble, Limestone	191,888
Clay and Clay products	Brick and Tile	1,078,541
	Pottery	11,394
	Pottery Clay and Kaolin	143,696
Mica	Sheet	266,650
	Scrap	33,943
Gold		172,001
Iron		116,472
Sand and Gravel		124,697
Barytes*		
Feldspar*		
Talc and Soapstone		21,501
Mineral Waters		18,745
Abrasives	Corundum, Millstones, Garnet	12,002
Quartz*		
Precious Stones		464
Copper		3,005
Silver		743
Monazite*		

*Included under "Miscellaneous."

Zircon*	$
Miscellaneous	*141,173
Total	$3,583,725

It will be noted from the above that a third of the mineral production is due to clay products; and it may be stated here that North Carolina is well supplied with good clays, not only for the manufacture of brick, tile, sewer pipe, etc., but she has an abundance of clay capable of being utilized in the manufacture of the finest grades of pottery and porcelain. At the present time this clay is being shipped to other states for manufacture, while it is perfectly feasible for it to be used in developing great home industries.

At this time, when the Nation is taking stock of its resources with a view to being prepared for any emergency, and the demand for raw materials is so great, North Carolina should make every effort possible to bring before the public her great natural resources and the many attractive investments she has to offer in her mineral wealth.

The Survey has in hand a great deal of data which could be published and distributed to great advantage to the State; but owing to lack of printing fund, we are unable to give much of this information to the general public.

The results of the investigations of the Geological Survey in regard to minerals are contained in the following reports:

Bulletin No. 1, Iron Ores.
Bulletin No. 2, Building Stones.
Bulletin No. 3, Gold Ores.
Bulletin No. 9, Monazite.

*Includes barytes, feldspar, quartz, monazite, and zircon.

Bulletin No. 10, Gold

Bulletin No. 11, Corundum

Bulletin No. 12, Gems.

Bulletin No. 13, Clay.

Bulletin No. 19, Tin.

Bulletin No. 25, Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus.

Economic Paper, No. 3, Talc.

Economic Papers, Nos. 14, 15 and 34, Gold and Copper.

Economic Paper, No. 15, Mineral Waters.

Economic Paper, No. 34, Feldspar and Kaolin.

Other ores have been studied in detail in regard to their geological and mineral occurrence and mining operation. The results of this work are given in the following publications:

Bulletin No. 21, Gold Hill Mining District.

Bulletin No. 22, Cid Mining District.

Volume I, Corundum and Peridotite of Western North Carolina.

Volume III, Coastal Plain Region of North Carolina.

The Survey collects each year statistics regarding the mineral production of the State, and these statistics are published as Economic Papers and Press Bulletins, in conection with which are given statistics of the changes that have taken place in the various mineral industries. New localities are described, new mining methods, etc. These reports are covered by Economic Papers, Nos. 4, 6, 7, 8, 9, 11, 14, 15, 23, and 34.

WATER-POWERS

North Carolina has been bountifully supplied with water-powers. It has been estimated that there is an available amount of about 450,000 horse-power. In 1908 the Census Bureau declared that about 141,000 horse-power of this was then developed. Since 1908 the electric power developed in this region has nearly doubled; so probably half of the State's water-powers are now under harness.

CONTROL

In 1915 two companies, the Southern Power Company and the Carolina Light and Power Company, controlled 75 per cent of the developed water-power, and eight corporations controlled 94 per cent of the water-power. Forty-nine municipalities have only 1 per cent of the water-power. The percentage of strictly public-service power controlled by the several corporations is greater even than the above figures would indicate.

PROTECTION

Water-powers cannot well be utilized beyond their minimum capacity without auxiliary power. The problem with power companies is to raise the minimum flow during two or three summer months. This may be done by building impounding reservoirs or by improving the land cover of the watershed. An unburned forest cover prevents erosion and regulates the flow of streams, making them higher in dry weather and lower in flood-time. For the protection of our water-power, the prevention of forest fires is most important.

STATE CONTROL OF WATER-POWERS

It is believed that all water-powers in North Carolina, other than those controlled by the Federal Government, should be subject to State control and subject to a reasonable charge to the State for the use of the water.

PUBLICATIONS

Water-power development of the State has been investigated by the Survey and the results published in Bulletins 8 and 20 on "The Water-powers of North Carolina."

WATER RESOURCES

The Survey has given considerable time to an investigation of the water supply of North Carolina, and a special report has been published on the underground water supply of the Coastal Plain region, which takes up each county separately and gives as far as can be determined the underground water area and the depth at which artesian water may be expected to be found. This report is published as part of Volume III, on the Coastal Plain Region of North Carolina. Considerable study has also been made of the underground water supply of the Piedmont region, but this has not been carried out in such detail as the Coastal Plain region, the underground water resources not being so extensive and the question of supply not so important to the Piedmont as to the Coastal Plain region.

There has been a very large demand for all these publications relating to the geology, mineralogy, and water supply of the State.

FISHING INDUSTRY

The commercial fisheries of Tidewater North Carolina represent one of the three natural resources of the State's wealth. Under this general heading are included finfish, oysters, clams, crabs, terrapin, etc. Since its establishment the Geological Survey has been actively interested in the study of conditions leading to the conservation and perpetuation of these industries, which have such tremendous possibilities for the State, both as a source of revenue and as the source of a great food supply. It was realized that the depletion or destruction of these industries would mean to the State—

Loss of income to the State;

Loss of means of livelihood to a large class of citizens in Tidewater North Carolina;

Loss of a food supply to the citizens of the State at large.

For a series of years the Survey, in coöperation with various Federal bureaus, has undertaken to study conditions governing our commercial fisheries and to ascertain remedies for the adverse conditions which appear to have been operating to the destruction of this great natural resource.

Through a series of investigations the facts seem to be established that the growing scarcity of fish was due, in the main, to *overfishing*, and that the remedy lay in some form of State legislation which would limit the open season and territory for fishing, give the fish a chance to enter and leave their spawning grounds at the proper seasons, and prevent the marketing of undersized fish.

It has also been ascertained through a series of experiments that certain shellfish, such as oyster and clam, etc., can be commercially cultivated in North

Carolina waters, and that there is the possibility of great industries growing out of the establishment of this fact, provided the State gives proper protection to these leased areas. Experiments have shown that the diamond-back terrapin can also be profitably cultivated.

Believing that the State should interfere to protect this great natural resource for the benefit of all the people, and that it would be to the best interests of the State to foster industries capable of yielding a great food supply and source of revenue to the State, the Survey has steadfastly advocated for a number of years the establishment of a State Fisheries Commission which would have jurisdiction over all the waters of the State. It is, therefore, believed that a new era was started in the development of the fishing industries of the State of North Carolina when the General Assembly passed, on March 4, 1915, "An act to establish a Fisheries Commission and to protect the fisheries of North Carolina."

This law, which is State-wide in its jurisdiction, is considered by nearly all those who have investigated it to be the most efficient and best Fishery law that has been passed by any State. Honorable William C. Redfield, Secretary of Commerce, in an address before the annual meeting of the National Association of Fisheries Commissioners on April 18, 1916, at Wilmington, North Carolina, said:

"I have taken no little pride, gentlemen of North Carolina, in pointing out personally to the Governors of other states and to the legislators of other states the progressive and effective law that exists here; a good law which has put the State of North Carolina in advance of others to its own good and to its great

*Public Laws of North Carolina, chapter 84, Session 1915.

honor. I know that it has had a marked effect upon opinion elsewhere; that it has put this State of North Carolina in a position of prestige and dignity and self-respect and of vision for the future, and of common sense as regards the children that are to come, which has made it honorable in the sisterhood of states in this country. The State of North Carolina has led the way in this respect, and others have shown it the flattery of imitation."

It is believed that this law will enable the State to build up its fishing industry to a point where it can be compared favorably with a similar industry in any other state.

While the North Carolina law has only been in operation a little over a year, yet we are beginning to realize that it was a very valuable piece of constructive legislation that the General Assembly of 1915 passed, and that splendid results are to be obtained under it. While it does delegate to a central body the control of the fisheries of the State, it is, we believe, the only way by which our fisheries can be conserved and increased. Previous local control has nearly wiped out the sturgeon industry of North Carolina and other states; it has greatly decreased the mullet industry by reason of the catching of undersized mullets; was rapidly depleting the striped bass and black bass fisheries; and it has nearly destroyed the oyster industry in this State and in others. On the other hand, where there has been a central control of fisheries there has been a general restoration of certain fisheries that had been nearly depleted.

If North Carolina will cater to the trade, and take particular care in the packing of the fish for transportation, in refraining from trying to put undersized fish on the market, and keep the fish in

their own class, so that a certain trade name will always mean a certain fish, there is no reason why the finfisheries of the State should not be greatly increased both in production and value. One phase of the work of the Fisheries Commission is along this line, and they are trying to have all the fish product from this State go out as North Carolina fish. With the increased railroad facilities in eastern North Carolina, it is now possible for the fisheries to ship their products into all parts of the country in competition with any of the other Atlantic states.

More attention is being given to the development of new fishing grounds, particularly to those off-shore on the submerged banks and in the surface waters; also, to a more thorough exploitation of the old fishing grounds.

Another means of increasing the industry which the State, through its Commission, has recognized and is trying to carry out, is to increase the abundance of fish through cultivation.

Still another means of increasing the industry, and which we believe is one of the more important ones, is the utilization of certain fishes which are now considered of little or no value. The United States Bureau of Fisheries has demonstrated conclusively that by a systematic advertisement, fish which are known to be palatable and are a good source of food can be made to become a very marketable fish. This is well illustrated in the tile fish, which, through the efforts of the Federal Government, has become a commercial fish of considerable importance. This bureau has also been successful in bringing the sea-mussel on the market as an article of food. Now they are considering a wellknown member of the shark family as a food fish, and personally I can see no reason why this particular member of the shark

family, which unfortunately is known as dog-fish, should not become a staple article of food marketed in steaks similarly as the swordfish. The suggested commercial name is grayfish.

With regard to the future of the finfish industry in North Carolina Dr. Hugh M. Smith stated:*

"The fisheries may be expected to deteriorate—

"(*a*) Through failure of the State to provide prompt and adequate protection to those fishes which begin to show a decrease in abundance. The history of the sturgeon is an unmistakable indication of what will eventually happen to the shad, alewives, striped bass, and other species unless ample provision is made for the survival of a sufficient percentage of the annual run until spawning has ensued.

"(*b*) Because of unnecessarily wasteful methods, such as the capture of larger quantities of food fishes than can be utilized or disposed of to advantage, and the useless destruction of large numbers of fishes of no present market value but of prospective importance.

"(*c*) Owing to careless methods of packing and preserving the catch, and to failure to keep abreast of the progress of the times in matters affecting the shipment and sale of fish."

The State is already taking cognizance of Dr. Smith's warnings (*a*) and (*b*), by the passage of the Fisheries Commission bill, which provides legislation for the protection of the fishes of the State and machinery for enforcing the laws. Also, the Commission has the authority to regulate methods of catching and disposal of fish, which will prevent the waste in warning (*b*). The question of methods of packing and preserving the catch is receiving serious

*North Carolina Geological and Economic Survey, Vol. II, page 412. 1907.

consideration and improvement is being made along this line.

Thus, there is every reason to believe that the fisheries of North Carolina will not only be maintained for an indefinite period, but will show marked growth in production and value.

OYSTER INDUSTRY

North Carolina at the present time not only does not hold first place in the country in the oyster industry, but, as has been stated by the Oyster Commission of Virginia,* "Maryland is far behind Virginia in the laws and methods of administration of its oyster industry, while North Carolina is hardly in the running." Since that time conditions have changed, and North Carolina now leads in laws and methods of administration, although not yet in production. If the present law can remain in force, it will not be many years before the oyster industry of North Carolina will be equal to that of any South Atlantic State.

In the case of the oyster, as with certain of the finfish, it will be necessary for the Fisheries Commission to insist that the oysters caught and marketed in this State *shall be put on the market as a North Carolina product.* The Pamlico and New River oysters are equal to those caught in any other state in this country, and if the beds producing these oysters are cultivated and protected and the oysters vigorously advertised, it will not be long before the Pamlico oyster and the New River oyster will be as widely known as the Lynhaven and the Blue Point.

The oyster canning industry is also capable of very large development in this State, and the Fisheries

*Virginia Fishing Industry. *Oystermen and Fishermen*, April, 1911, page 9.

Commission are already taking steps to obtain legislation which will prevent the North Carolina canned oyster from being shipped as Virginia stock.

ESTABLISHMENT OF HATCHERIES.

In regard to the cultivation of fishes in North Carolina, this State was one of the first to take up artificial propagation of fishes. We believe that the State can make no better expenditure of funds in connection with the fishing industry than in systematic fish culture, and we feel that it is the duty of the State to establish and maintain several small hatcheries to assist in the replenishment of certain desirable fishes in our upland as well as lowland streams. This State has had the hearty coöperation of the Federal Government in the development of its fisheries, and the United States Bureau of Fisheries has maintained a shad hatchery at Edenton for a great many years.

With the passage of the Fisheries Commission act, which should insure the enforcement of laws and the protection of the fish, there is still more reason for an increased number of hatcheries in this State, and greater coöperation of the State Commission with the United States Bureau of Fisheries. It is to be hoped that the two Commissions will take up the artificial propagation of the sea-mullet, spotted squeteague, and other valuable salt-water species, in addition to the cultivation of the brook trout, rainbow trout, small-mouthed black bass, and spotted cat-fish, for the mountainous regions; and the large-mouthed black bass, strawberry bass, and various sunfishes, for the lowland waters.

SURVEY PRINTING

One of the greatest handicaps to the work of the Survey during the past two years has been the lack of funds for printing the reports giving the results of its investigations. The act establishing the Survey imposes the duty of studying conditions relating to the natural resources of the State and in making reports to the people as to the results of these investigations. To be of value to the State, these reports should be distributed at the time when they would have the most value, either in conserving the interests of the people or in advertising our resources when such resources are in most demand. Delay in publication may mean, and often does mean, the withholding of information which costs the State many thousands of dollars because of delayed action which may have resulted through the publication and distribution of the information compiled from a given investigation.

The expenses of a number of our investigations have been borne by Federal departments, organizations, and in some cases by the authors themselves: as, in the study of the Coastal Plain Region the Survey has had the very close coöperation of the United States Geological Survey; in the preparation of the volume on the North Carolina Birds (which was almost through the press and was destroyed by the fire which burned the plant of E. M. Uzzell, public printer) we have had the coöperation of the National and State Audubon Societies; in the collection and compilation of our mineral, forest fire, and road statistics, we have worked in coöperation with the United States Geological Survey, United States Forest Service, and United States Office of Public Roads and Rural Engineering, having the advantage with the

Office of Public Roads and Geological Survey of franked envelopes in sending out statistics, blanks and obtaining replies; and the entire cost of the preparation of the volume on the Mushrooms of North Carolina has been borne by the author, Dr. W. C. Coker, of the University of North Carolina.

These volumes are of great value to the State, and could not have been prepared within any reasonable time if any consideraple portion of the cost of preparation had been dependent upon the funds allotted to the Survey. Their publication is now being delayed because of the lack of printing funds, and it seems to us that the present Legislature could do no greater service for our people, in giving them the benefit of the knowledge obtained through these investigations and in advertising the State's resources, than to provide funds sufficient to give this information to the public.

PUBLICATIONS

OF THE

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*

2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*

3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*

4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*

5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*

6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*

7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*

8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*

9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Postage 4 cents.*

10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*

11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Postage 4 cents.*

12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*

13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*

14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*

15 Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*

16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents.*

17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*

18. Bibliography of North Carolina Geology, Mineralogy, and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy 30 cents extra.*

19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp .,8 figs. *Postage 4 cents.*

20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*

21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents.*

22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 115 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D., 1916. 8°, 120 pp., 3 pl. *Postage 15 cents. Cloth copies 50 cents extra.*

ECONOMIC PAPERS

1. The Maple-sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead, and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a list of Minerals found in North Carolina; describes the treatment of Sulphuret Gold Ores, giving Localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals" describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Postage 2 cents.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines Worked for Gold in 1903; descriptions of properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon, Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving method of Cleaning and Preparing Barytes for Market; de-

scribes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives new Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and Treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of

the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina. Compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Postage 4 cents.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Postage 3 cents.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 15 cents.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extract from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During

1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911. Compiled by Joseph Hyde Pratt, State Geologist, 1912 8°, 45 pp. *Postage 3 cents.*

27. Highway Work in North Carolina containing a Statistical Report of Road Work During 1911, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912., 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention Held at New Bern, N. C., December 13, 1911. Compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the Two Trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist, 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads Are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; The new Milling Process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's plant; notes on the

Carter Mine, Montgomery County, by Claud Hafer; also a de-Geological Survey Report by Douglas B. Sterrett; a report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of Producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5 and 6, 1913. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association held at Morehead City, N. C., July 31-August 1, 1913, in Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina during 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 15 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat, N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary, 1916. 8°, 128 pp. *Postage 15 cents.*

VOLUMES

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 50 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents. Cloth-bound copies $1 extra.*

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Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

BIENNIAL REPORTS

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone; Geological Work in Coastal Plain Region, including supplies of drinking-waters in eastern counties; Report on Forests and Forest Products, Coal and Marble; Investigations of Diamond Drill.

Biennial Report, 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

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Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

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Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

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Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

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Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

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Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

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Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and Counties partly or wholly topographically mapped; description of special Highways in North Carolina; suggested Road Legis-

lation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract; Buncombe County, Transylvania County State Farm, certain Watersheds, Reforestation of Cut-over and Abandoned Farm Lands, on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the Use of and for the Protection of Meridian Monuments and Standards of Measure at the several county-seats in North Carolina; list of Magnetic Declination at the county-seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by U. S Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over this Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorns, Asheboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the U. S. Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on forest fire conditions in the northeastern States, by J. S. Holmes. Report on the work of the U. S. Forest Service in North Carolina in connection with the pur-